

METRIC PRACTICE GUIDE

ACKNOWLEDGMENTS

The production of the Alaska DOT&PF (Department of Transportation and Public Facilities) Metric Practice Guide has been a cooperative effort, realized over a long period of time.

Credit is due Jerry Murphy, who was State Metric Coordinator from 1992 to 1994. Gene Rehfield is the current State Metric Coordinator, and is the editor of the Metric Practice Guide.

Portions of the technical material were excerpted from the State of Colorado Metric Conversion Manual, and are used by permission.

We hope that you find the information useful in your work. Comments, questions or corrections are welcome. They can be sent to us at:

State of Alaska
Department of Transportation and
Public Facilities
3132 Channel Drive
Juneau, AK 99801-7898

Phone (907)-465-6968 Fax (907)-465-2460
Internet Gene_Rehfield@dot.state.ak.us

METRIC PRACTICE GUIDE

TABLE OF CONTENTS

	PAGE
DISCLAIMER_____	v
PREFACE_____	vi
INTRODUCTION_____	vii
 CHAPTER 1 GENERAL	
TABLE OF CONTENTS_____	1
1.1 INTRODUCTION _____	2
1.2 SCOPE _____	2
1.3 STATUS OF METRICATION _____	3
1.4 ORGANIZATION _____	5
1.5 METRIC PHILOSOPHY _____	6
1.6 PARTNERING WITH THE CONSTRUCTION COMMUNITY _____	7
(REF. 4.6 - CONTRACT ADMINISTRATION)	
 CHAPTER 2 METRIC UNITS	
TABLE OF CONTENTS_____	8
2.1 INTRODUCTION _____	9
2.2 BASE UNITS _____	9
2.3 DECIMAL PREFIXES _____	10
2.4 DERIVED UNITS _____	10
2.5 CONVERSION FACTORS _____	11
2.6 PROCEDURAL RULES _____	14
2.7 CONVERSION & ROUNDING RULES _____	17
2.7.1 HARD VS SOFT CONVERSION_____	17
2.8 COMMON USAGE _____	19
 CHAPTER 3 PRECONSTRUCTION	
TABLE OF CONTENTS_____	21
3.1 INTRODUCTION _____	22
3.2 PREPARATION _____	22
3.3 SPECIFICATIONS _____	23
3.4 ADVERTISEMENTS _____	24
3.5 CODES & STANDARDS _____	24
3.6 RIGHT-OF-WAY/SURVEY_____	26

3.7 ROADWAY DESIGN____	32
3.8 STRUCTURES_____	57

CHAPTER 4 CONSTRUCTION

TABLE OF CONTENTS_____	59
4.1 INTRODUCTION _____	60
4.2 PREPARATION_____	60
4.3 TOOLS & EQUIPMENT _____	61
4.4 SURVEYING _____	61
4.5 TEST PROCEDURES _	61
4.6 CONTRACT ADMINISTRATION _____	61
4.7 SUBMITTALS _____	62
4.8 TRAINING _____	62

CHAPTER 5 RESOURCES

TABLE OF CONTENTS_____	63
5.1 METRIC CLEARINGHOUSE_____	64
5.2 PROFESSIONAL & TECHNICAL SOCIETIES _____	64
5.3 GOVERNMENT _____	68
5.4 TRAINING MATERIALS _____	72
5.5 GENERAL PUBLICATIONS _____	72
5.6 INTERNATIONAL _____	73

CHAPTER 6 PRODUCTS

TABLE OF CONTENTS_____	75
6.1 MATERIALS_____	76
STRUCTURAL STEEL_	77
FASTENERS _____	77
STEEL FABRICATION_	78
REINFORCING STEEL_	78
STEEL PLATE_____	80
SHEET METAL_____	81
STEEL WIRE_____	82
SIEVES_____	84
HARD CONVERSION FOR CONSTRUCTION MATERIALS_____	86
6.2 TOOLS (RESERVED)	
6.3 BLOCK (RESERVED)	
6.4 GLASS (RESERVED)	
6.5 ANCHOR BOLTS (RESERVED)	
6.6 NUTS (RESERVED)	
6.7 STRUCTURAL BOLTS (RESERVED)	
6.8 LUMBER (RESERVED)	

DISCLAIMER

This manual or any part thereof must not be reproduced in any form without the following disclaimer.

The information presented in this publication has been prepared in accordance with recognized engineering principles and is for general information only. While it is believed to be accurate, this information should not be used or relied upon for any specific application without competent professional examination and verification of its accuracy, suitability, and applicability by a competent licensed engineer or other licensed professional. Publication of the material contained herein is not intended as a representation or warranty on the part of the State of Alaska that this information is suitable for any general or particular use or of freedom from infringement of any patent or patents. Anyone making use of this information assumes all liability arising from such use.

Caution must be exercised when relying upon the specifications and codes developed by other bodies and incorporated herein, since such material may be modified or amended from time to time subsequent to the printing of this edition. DOT&PF bears no responsibility for such material other than to incorporate it at the time of the initial publication of this edition, subject to the general comments set forth in the preceding paragraph.

PREFACE

The United States must commit to metrication. Two overwhelming factors, the adoption of the metric system by the remainder of the world and the changing global economy, mandate that this nation must change.

This guide has been written to provide an explanation of the need for the change, and to serve as a resource to help bridge the gap between building roads in the English-based system of units and the Metric system. It is intended that this guide be used as a reference manual for DOT&PF employees.

The AASHTO (American Association of State Highway and Transportation Officials) Metric Task Force requested that each AASHTO Highway Subcommittee and task force develop a position and recommendations addressing metrication items in their area of responsibility.

The AASHTO committees and task forces are attempting to address the metrication impacts in all areas of highway transportation. It is possible that different task forces will adopt different criteria for the same items. It may be that as the highway industry begins to use the criteria, they may be revised. Thus, some metric criteria in this guide may require change at a later date.

The reader is advised to seek the most recent version of AASHTO policy on these issues.

INTRODUCTION

The United States is converting its transportation system to the metric system, and the date that the Federal Highway Administration has established is September 30, 1996. After that date, no highway projects may be paid for with Federal Lands Highway or Federal-aid Highway funds unless the plans, specifications and estimate (PS&E) are all in metric units. Exceptions to this rule may only be granted by the FHWA Regional Administrator.

LEGAL BASIS FOR HIGHWAY CONVERSION

Metric Conversion Act of 1975 & Omnibus Trade and Competitiveness Act of 1988

The impetus for the change came from Congress. *The Metric Conversion Act of 1975* encouraged metrication, but left it as a voluntary activity. As a consequence, virtually no metrication took place. The *Omnibus Trade and Competitiveness Act of 1988* amended the 1975 Act to designate the modern metric system (System International, or SI) as the preferred system of weights and measures for U.S. trade and commerce. It also requires each federal agency to convert to metric, and requires each federal agency to use metric in its procurements, grants, and other business-related activities to the extent economically feasible.

These acts did not mandate that individual states, cities, counties, industries, or other organizations convert to metric. However, these entities cannot obtain federal roadway money unless they use metric. It is probable that all will convert to metric to remain eligible for road funds, and it is best that we all convert quickly, using consensus guidelines.

Executive Order 12770

In addition to the congressional legislation, Executive Order 12770 was issued in July 1991. It required each federal agency to adopt a metric conversion plan by November 30, 1991. Among the other provisions of the executive order were instructions that the Department of Commerce was to lead the metrication effort.

The Federal Highway Administration Metric Transition Plan was approved by the Secretary of Transportation in October 1991. It laid out procedures and administrative policies for the conversion, and established certain milestone dates. For example, after September 30, 1992, FHWA publications and correspondence were to use metric as the primary system of units for all measurements. FHWA manuals and documents were to be systematically revised and republished in metric so they would be available to guide the conversion. The key date is September 30, 1996. All construction contracts advertised for bids after that date must contain only metric measurements for any federal lands highway or federal-aid highway construction project.

U.S. DOT Metric conversion Planning Guidelines

On May 8, 1990, the U.S. Department of Transportation (U.S. DOT) issued Order 1020.1C, which established policy and administrative procedures for the transition. A change to the order was published in January of 1991. It was further amended and issued as Order 1020.1D on March 23, 1992. The Order defines SI as the official metric system, and refers to ASTM E 380 and several other industry standards and documents for guidance on conversion from U.S. units to SI.

The U.S. DOT order requires agencies to develop plans for conversion to SI to the extent practical. These plans are to include specific dates for changeover to SI in procurements, grants and other business-related activities. U.S. DOT is to participate in the Interagency Committee on Metric Policy, and a U.S. DOT Metric Coordination Committee was created. The Order also contains guidance to U.S. DOT agencies to assist them in completing their conversion plans.

The U.S. DOT Metric Coordinator indicated in early 1992, "It is now the policy of the Department to pursue and promote an orderly changeover to the SI system." He also noted that there were nine comprehensive metric conversion plans in place for the nine U.S. DOT agencies, including the Federal Highway Administration (FHWA).

NECESSITY FOR CONVERSION

As of 1990, there were only three nations that had not converted to metric: Burma, Liberia, and the United States. Subsequently, these three nations faced serious difficulties in exchanging information with other nations, in conducting international trade, and in performing engineering or construction work with other countries.

The current global economy presents another serious difficulty. At the end of World War II the United States was the center of world commerce. At that time America produced 75% of the world's products; today that value has shrunk to 25%. The world economy has changed rapidly, and industry in the United States is being placed at an increasing disadvantage because of its non-metric system of measurements. American firms are sometimes excluded from doing international business when unable to measure goods in metric terms. A few facts will help put this into perspective:

- The European Community (EC) is composed of 12 nations and is potentially the world's most powerful market, surpassing the United States. The EC specified that products with non-metric labels will not be permitted for sale after 1992.

- The largest U.S. trading partners, Canada and Mexico, are predominantly metric countries.
- Japan has identified the non-metric nature of U.S. products as a specific barrier to the importation of U.S. goods.

Simplicity

Perhaps the strongest argument in favor of the metric system is its simplicity of use. It is completely decimal-based. There is no need to convert from one type of measurement to another type of measurement. For example, inches do not have to be converted to feet. Feet do not have to be converted to miles. Tablespoons do not have to be converted to cups. There is no requirement to change 27 feet, 8 1/4 inches into the equivalent number of yards.

The universal experience of every country that has converted has been that the metric system was easier to learn and easier to use than the convoluted system currently being used in the United States. It is just getting the transition underway that is hard. Once the mental leap has been made, calculations are much, much easier.

One Unit for Each Property

One of the greatest advantages is that there is only one unit for measuring each physical property. For example, pressure may be measured by psi, psf, kips/sf, inches of mercury or other units in the conventional U.S. system. The SI system has only one unit for pressure, the pascal. Another example involves power, which may be measured in hp, btu's, watts, and several other terms. In SI, it is measured only in watts. Therefore, metric is a more coherent system in that only one unit is used for each physical quantity and there are no conversion factors to remember.

Conclusion

Metric's coherency, its simple base units, and its use of decimal arithmetic make it an especially logical and useful measurement system. The American construction community is able to meet the metric conversion challenge in federal construction, and it is in our long-term strategic interest to do so.

There will be initial effort involved. Firm resolve, close cooperation between the public and private sectors, and creative application of our extensive talent and expertise will allow the challenge to be successfully met.

BENEFITS OF METRIC CONVERSION

Metric is the world's measurement language. Fewer and fewer cultures are familiar with U.S. measurement units, and many are increasingly unwilling to overcome this hurdle in order to purchase and utilize American goods. The costs associated with doing business in this country (labor, taxes, tariffs, etc.) make it difficult for U.S. firms to produce their goods at prices which are attractive to other nations. They do not need the additional handicaps of non-standard sizes and a measurement system which is the exception rather than the rule.

International Competitiveness

Greater industrial efficiency and international competitiveness are available through the metric system. Canada has already converted to metric. The Canadian Metric Association reported that metric produced direct benefits in terms of reduction in design costs and times, increased construction efficiencies, and improved material and component dimensioning techniques.

Private Sector Conversions Already Underway

Some U.S. businesses have already converted. One of the earliest industries to be affected by metrics is the automobile manufacturing sector. General Motors made an early decision that it must convert its manufacturing. Surprisingly, total conversion costs for GM were less than 1% of their original estimates. IBM and Otis Elevator are other examples of firms that have switched to metric, in these cases to increase international competitiveness and to reduce their parts inventories. The wood industry has converted to metric for international sales. Timber products are being shipped overseas in metric sizes.

Opportunity to Consolidate or Redesign

The conversion process allows industries an opportunity to rethink their designs and to incorporate efficient practices. One way to do this is to designate fewer product sizes, reducing inventories and eliminating some manufacturing equipment. Rationalization of fastener sizes during metric conversion allowed IBM to reduce its number of fasteners from 30,000 to 4,000. The liquor industry reduced the number of container sizes from 53 to 7 during its metric conversion.

International Market for Engineering Services

Many American design and construction firms have already begun using metric units for their foreign work. Foreign billings for American architecture/engineering contracting firms amounted to \$3.2 billion in 1989, a substantial amount of business.